REPORT ON THE FORESTS OF THE NORTH TRIANGLE, KACHIN STATE, NORTH BURMA

BY

F. KINGDON-WARD, B.A. (Cantab.), O.B.E., F.L.S., V.M.H.

A general description of the vegetation and flora of North Burma was published in four parts in the *Journal of the Bombay Natural History Society*, Vols. xliv, xlv, xlvi (August 1944 to August 1946), under the comprehensive title 'A Sketch of the Botany and Geography of North Burma'. This is referred to in what follows as 'the earlier monograph'.

The present paper is a direct continuation of those observations, dealing with a part of North Burma not previously mentioned since no botanical collecting had ever been done there—namely, the North Triangle, between the eastern and western branches of the Irrawaddy. Here, between December 1952 and January 1954, my wife and I together with two Burmese colleagues, U Tha Hla and U Chit Ko Ko, seconded from the Burma Forest Department, spent eight and a half months.

Though I have not attempted to reconcile in detail the vegetation zones recognised in the Triangle with those previously discussed, the use of the same names for the same zones leaves no room for confusion.

INTRODUCTION

Our objective in 1953 was the region known as the Triangle, situated in the Kachin State of the Union of Burma, north of Myitkyina. No serious botanical collecting had ever been done in this area; and though, as a result of previous exploration in adjacent areas, it was known what types of vegetation and what sort of flora would occur there, it required and still requires much further work to give a complete picture of North Burma.

The ultimate goal decided on was the group of high peaks forming part of the watershed between the eastern and western branches of the Irrawaddy. It is amongst these peaks that the Hkrang Hka, a left bank tributary of the Mali Hka (or western branch), rises. The approximate position of the group is 26°50′N., 98°15′E., the highest peak called Tamā Bum rising to 11,845 ft. above sea level. I shall refer to them as the Arahku peaks.

The Triangle, whose apex is the confluence of the two branches of the Irrawaddy at Tanghpore, 27 miles above Myitkyina, and whose ill-defined base lies a little north of the 27th parallel of latitude, is entirely mountainous. In fact, North Burma and north-eastern Assam together make up part of the under belly of the Sino-Himalayan plateau, which stretches for 2,000 miles across Asia. This under belly has been so deeply and widely eroded that it no longer bears any outward likeness to a plateau, and has in fact become somewhat detached from the main plateau; and although this isolation is geologically recent (dating only from the beginning of the Pleistocene

glaciation), the climatic and other changes then initiated have left indelible marks on the flora.

While, therefore, the vegetation and flora of North Burma in general and of the Mali Hka-Nami Hka watershed in particular could readily be inferred from what was already known of the surrounding areas, there was good reason to think that many new species remained to be discovered, even though the height of the peaks in the Triangle did not warrant belief in an extensive alpine flora. And so it proved.

There would, of course, be less scope for new vegetation types than for new species, since it takes a major climatic change acting over a long period of time to bring about the former, whereas new species may result from much smaller causes and in much less time. We established that the North Triangle had been glaciated, which glaciation lasting through perhaps half a million years, must have brought about a fundamental change of vegetation types; but these types would not differ appreciably from other vegetation types of North Burma, where the marks of glaciation are even plainer.

Change of climate alone, consequent on the Pleistocene glaciation, is, however, not the only reason for the unusually rich and varied flora of North Burma. The dynamic events of the changeful and intermittent ice age have certainly been a major factor, causing migration, extermination, and re-introduction of species. But not less important has been the isolation of areas, the compression and telescoping of several phytogeographical regions within a small area, and the immigration of new species. Here, differences of altitude have played a major role by bringing different floras into three-dimensional contact. (On the plains they can be in two-dimensional contact only.)

Over large parts of the earth's land surface, the phytogeographical regions are in contact, if at all, in two dimensions only, being separated from one another by deserts, by oceans, or by mountain ranges. In the Triangle, as in many other mountainous areas, they are in contact in three dimensions. It is not necessary to follow up all the implications of this truth here; but it is obvious that, whereas the alpine region is the most isolated, the temperate region, between 5,000 and 10,000 ft., is in close and uninterrupted contact with two distinct phytogeographical regions—Indo-Malaysian below, and alpine Sino-Himalayan above; which perhaps accounts for the fact that the temperate zone is the most prolific of all in endemic species.

Previous Work

Something was known of the vegetation and flora of four areas of North Burma outside the Triangle, all of which lie within 150 miles of the group of peaks we wished to explore. These areas include:

(i) the Myitkyina plain to the south;

(ii) the Htawgaw and Hpimaw Hills and western Yunnan to the south-east;

(iii) the Hkamti plain and the Seinghku and Adung valleys to the north;

(iv) the Taron valley and Irrawaddy plateau to the north-east. (For an account of the Irrawaddy Plateau see the *Geographical Journal,* October, 1938.)

It was certain that the flora and vegetation of the North Triangle would have a great deal in common with these areas; but even they had been only superficially explored, and there was still a great deal to be learnt about North Burma—particularly in the Triangle, which in the botanical sense, had never been explored at all. A complete list of these previous explorations has been given in the earlier monograph, Part I; so there is no need to repeat it here.

Preliminary Preparations

After discussing my plans with the Chief Conservator and the Sylviculturist, Burma Forest Department, it was arranged that two Range Officers of the Department, U Tha Hla and U Chit Ko Ko, should join the expedition for training in plant exploration and botany, and to help us in any difficulties which might arise. I cannot speak too highly of their enthusiasm, loyalty, and unselfish co-operation. Thus, the four of us made up a team which worked together harmoniously throughout, to make the most of our unique opportunity. It is certain that my wife and I, the two most experienced members of the team, would not have achieved the results we did without the help of our Burmese colleagues.

We had brought our stores, tents, and equipment out from England, and the business of landing and clearing these, obtaining the necessary permits from the Union and Kachin Governments, and so forth occupied us in Rangoon for six days. My wife and I finally left for Myitkyina on the 18th December, 1952, our Burmese colleagues arranging to join us later.

Route

We left Myitkyina by jeep on the 5th January, 1953, reaching Sumprabum (131 miles by road) on the 7th. Here we halted for two and a half months. The Arahku peaks and the ranges to the north were under snow, and I did not think we should find much in flower in the temperate forest before mid-April; but in this I was mistaken. The time was well spent making a representative collection in the neighbourhood, pushing out stores into the Triangle, purchasing rice, and studying the country.

Seen from here the Arahku peaks, about 50 miles to the north-east, appeared to consist of a series of short, more or less overlapping chains arranged in echelon. Due to their height they are somewhat isolated on the spine of the Triangle, and seem to bear little relation to their visible surroundings; they are like islands in an ocean.

Two days before we set out for Arahku, U Tha Hla and U Chit Ko Ko (who had been delayed by unforeseen difficulties) joined us. They arranged to follow us in a few days.

On the 21st March we started on foot, crossed the Mali Hka at Ningma Daru by dugout, and four days later reached the Hkrang Hka, which we crossed by bamboo raft. Throughout the ten

days' journey to Arahku we followed a general north-easterly direction, halting at Arahku for a profitable five days' exploration. On the 7th April we reached Hkinlum, the last village up the main valley and close under the peaks, having marched 86 miles. Here we made our base camp. On the 12th we were joined by U Tha Hla and U Chit Ko Ko; so our party was now complete.

Though Hkinlum is at exactly the same altitude as Sumprabum, we noticed at once that certain trees familiar at the latter place were lacking here; for example, *Ficus benjamina*, *Duabanga sonneratioides*, *Aesculus assamica* (?—or *A. punduana*?), *Shorea assamica*, *Dipterocarpus tuberculatus* (?), *Michelia* sp. nov. (only three specimens found), *Altingia excelsa* and *Terminalia myriocarpa*. Several of these, however, became prominent further down the valley of the Hkrang Hka. Their absence at Hkinlum was obviously connected with the proximity to the high peaks. On the other hand, a number of trees not seen at Sumprabum were prominent at Hkinlum; e.g. *Prunus cerasoides rubella*, *Bucklandia populnea*, *Manglietia caveana*, *Michelia bailloni*, *Alcimandra cathcartii*, *Myrica nagi*, *Acer campbelli* (?), and others. It cannot, however, be too strongly insisted that, below 5,000 ft., the flora of the two areas is essentially the same, such differences as there are being mainly due to minor differences of climate, which here means temperature differences.

Climate

A fairly comprehensive picture of the climate of North Burma is given in the earlier monograph, Part I, and I can add little that is new here. The climate of the Triangle does not differ appreciably from that of other comparable parts of North Burma—that is to say, prolonged summer rain, followed by a drier cold weather. The four seasons are well marked, and become more so with increase of altitude up to about 9,000 ft.

In 1953 spring in Hkinlum (4,000 ft.) was abnormally wet. This was followed by a comparatively rainless August, the break in the monsoon lasting about a month with temperatures up to 90°F. and high humidity. Such August breaks, however, as I recall, are not unusual in North Burma, when little rain falls—and that mostly in the form of short thunder storms, often at night. The fact is that, in mountainous North Burma, microclimates within the general monsoon framework are common. The most obvious deviation from the familiar monsoon climate of Burma is, of course, the presence of a sub-arctic climate in the north (becoming cold-temperate in the Triangle), which affects adjacent areas. Ground frosts occur so low as 4,000 ft. (as at Hkinlum, where the hillsides have been cleared); while above 10,000 ft. snow lies deep for three or four months.

The Vegetation Types of the North Triangle

North Burma is almost completely covered with forest. There are three minor—but none the less important—exceptions to this:

I. *The banks of rivers*, especially between low water mark and flood level; also small areas above high flood level which are covered

with sand. (In the latter the vegetation shows a transition to forest, though the species are often peculiar.) This river valley vegetation is, of course, no more than a narrow strip lining either side of the permanent stream bed; but along the many hundreds of miles of rivers, large and small, it amounts to a considerable area, and the immersible vegetation type includes a surprising number of species.

Four distinct habitats are met with:

(*a*) rocky cliffs;
(*b*) pure sand;
(*c*) continuous stretches of comparatively small water-worn stones, with no sand or soil visible between them;
(*d*) piled-up boulders.

Silt rarely occurs, and where it does locally it is due to the presence of a small, slow jungle stream. There are, however, gradations between (*b*), (*c*), and (*d*), with occasional (and often temporary) admixtures of silt. Above flood level, sand is almost always piled up on low shores for a greater or lesser distance; but vertical cliffs, or boulder banks, are followed immediately by thick forest.

Each of the above habitats has its characteristic species, besides species common to more than one habitat. The most interesting plants of this sere (i.e. temporary stage on the way to forest) are those which at some period are more or less submerged, especially shrubs. They may be gregarious, like *Homonoia riparia*, scattered, or in dense mixed thickets, where such plants as *Eugenia*, *Phlogacanthus*, *Phyllanthus*, shrubby *Strobilanthes*, *Mussaenda*, *Ligustrum*, *Rosa*, *Camellia*, *Rhododendron simsii*, and others occur. There is even a species of *Euonymus* with minute flowers.[1]

The leaves of almost every shrub annually submerged are long and narrow, either narrow-lanceolate or linear-lanceolate, and leathery. This is true of all the species mentioned above except *Mussaenda* and *Rosa involucrata* which, with a species of *Phyllanthus* growing under similar conditions, have finely divided leaves. Other examples of narrow-leafed plants are *Ficus pyriformis*, *Scutellaria*, *Salix tetrasperma*, several grasses, ferns, and Cyperaceae. A much smaller, completely prostrate undershrub is the curious *Rhabdia lycioides* which grows in almost pure sand, usually well below high flood level. Herbaceous plants include a creeping fern (*Goniopteris*) and the Arm-like *Cryptocoryne*, which forms compact colonies wedged between stones. Most of this strand flora flowers either in the winter at low water, after the river has begun to fall in October, or in the hot weather of March-April.

From the practical point of view, a knowledge of this river bank sere is imperative for the selection of plants suitable for reclamation work.

It is important to remember that this river bed formation, stabilised at sere level, is open, and can easily absorb many more species, if they can comply with the conditions.

---

[1] This is possibly the *lapu shin lap* of the Kachins (Burmee *mway kike* say) a well-known remedy for snake bite (*some* snake bites?).

II. *The zone of cultivation* which extends intermittently from the lower valleys, less than 2,000 ft. above sea level, to about 6,000 ft.: Between these limits, much of the country has been cleared of forest and is covered with crops, or with second growth undergoing several metamorphoses before its final return to climax forest—which of course it is never permitted to do. Cultivation, however, is confined to south and west slopes; north and east slopes, precipitous rocky slopes, gullies and ravines, are untouched. Thus, even within the zone of cultivation, in the most thickly populated districts, a good deal of climax forest survives.

Many widespread herbaceous and undershrub plants occur in this zone. Some of these are found in connection with cultivation all over South-East Asia, and even further afield; certain Compositae and grasses, for example. These plants are provided with good means of dispersal and quickly seize on unoccupied ground as soon it becomes available, either through the felling and burning of forest for *taungya* cultivation, or the cutting of paths.

Many orchids, too, which will not grow inside the dank forests, are able to establish themselves on solitary trees left standing on cultivated slopes. They, like many other herbaceous plants commonly found on roadside banks, are as much a part of the Indo-Malayan flora as are the forest trees, to which they are necessary. They are not, like weeds of cultivation, intruders, though they may appear to be so because in the forest they are much more scattered. Such Indo-Malayan or pantropic herbaceous plants include species of *Begonia*, *Chirita*, *Impatiens*, *Viola*, *Didymocarpus*, *Ohiopogon*, many ground orchids, Cyperaceae, Gramineae, and others.

Some of the most interesting herbaceous plants met with were those which occur only in villages, brought in perhaps long ago from outside by the people themselves. Examples are: *Iris* sp. (allied to *I. wattii*) and *Hemerocallis*, neither of which sets seed, and neither of which grows outside the village, though the iris at least occurs in almost every village. The same is perhaps true of the Tea bush (*Camellia sinensis*) in the warmer zone, and of another species of *Camellia*, which might be a substitute for Tea in the cooler zone found only in Hkinlum and adjacent villages.

The presence of these plants is suggestive, and a knowledge of their occurrence and distribution might furnish valuable clues to anyone enquiring into the history of the hill tribes of North Burma. One feels compelled to ask, who brought these plants here? and when? and whence? Above all, *why?*

III. *The apline zone* on the mountain tops, where they exceed 10,000 ft. This is probably the most extensive non-forested area in North Burma.

The alpine vegetation may consist of elfin wood (especially *Rhododendron* species), or of scrub (also largely *Rhododendron*, with *Prunus, Sorbus, Vaccinium*), or of *Arundinaria* with a few scattered undershrubs; all three exclude tree growth.

Where the summits reach 17,000 or 18,000 ft. there is an extensive zone above the tree line filled with alpines—the real arctic alpine

vegetation, or, as the limit of plant life is approached, open ground with widely scattered herbaceous plants. Even moss and lichens are rare here, and of few species.

At lower altitudes an alpine vegetation clothes the precipitous ridges which lead up to the exposed wind-swept summits. It also descends the steep gullies, which are kept open by running water and falling rocks.

In its extreme form, above 12,000 ft., the alpine vegetation consists of turf and sedge, with many scattered and gregarious flowering plants, either of low stature (*Pleurogyne*, *Lloydia*, *Cremanthodium*, *Gentiana*, *Saxifraga*, *Parnassia*, *Viola*), or forming flat compact mats pressed against the rocks (*Androsace*, *Arenaria*, *Rhododendron*, *Diapensia*) in great variety. This alpine flora is comparable with the European alpine flora, or with the flora of the Arctic; and so also is the vegetation type. It includes a number of endemic genera (*Omphallogramma*, *Cremanthodium*, *Oreosolen*, *Nomocharis*), besides entire sections of large genera such as *Primula* and *Rhododendron*, sufficient to raise the alpine and sub-alpine region of North Burma to the rank of a phytogeographical region (Sino-Himalaya), in spite of a considerable element of Arctic and northern forms.

Not only were there many familiar North Burma alpines here, and a few new species (*Primula*, *Nomocharis*, *Veratrum*?); but a considerable number of species—especially alpine undershrubs common on mountains 15,000 to 18,000 ft. high further north—were lacking on the alpine tops of these lower peaks. For example, we found no species of *Berberis* or dwarf *Lonicera*, and only one species of the following: *Cotoneaster*, *Salix*, *Spiraea*; while two whole series of *Rhododendron* ('*Laponicum*' and '*Saluenense*') could not provide a single species between them. Further north, seven species belonging to these two sections are found in the alpine region. Another widely distributed alpine undershrub—*Potentilla fruticosa*—was not found; but *Rosa omeiensis*, *Vaccinium modestum*, *Sorbus pygmea* (?), and two alpine mat-forming Gaultherias occurred. There was also a dwarf Juniper.

No *Fritillaria*, *Notholirion* or *Meconopsis* was seen; and even the genus *Primula*, in sub-alpine and alpine zones combined, was represented by only four species, of which at least two appear to be new.

Thus, as might be expected, the alpine vegetation of the Arahku peaks—though many species must have remained undetected—was poor compared with that of the higher peaks to north and east. I counted only between 60 and 70 alpine and sub-alpine species together, including *Omphallogramma* (two species), *Cremanthodium*, *Arenaria*, *Pleurogyne*, *Gentiana*, *Saxifraga* (two species), *Bergenia*, *Lloydia*, *Androsace*, *Parnassia*, and *Tofieldia*.

This Sino-Himalayan flora is the most isolated of all the vegetation types of North Burma, and is discontinuous, the mountain top floras being cut off from one another by deep forested valleys. Different ranges running south from the Tibet plateau, though possessing the same general flora, seem to possess species peculiar to themselves.

Types of Forest in the North Triangle

The forest cover of North Burma is divisible into five main types, of which three are represented in the North Triangle; these are stratified according to altitude. The three types represented are:

(i) *Tropical Broad-leafed Evergreen Forest*, which is a northward extension of the Indo-Malayan phytogeographical region. In the Kachin State this type still persists in the low-lying valleys to about 28°N.; and in the Arahku-Hkinlum area it reaches an extreme altitude of about 6,000 ft., though it is more characteristic of the river gorges at 3,000-4,000 ft.

(ii) *Temperate Broad-leafed Rain Forest*, which is in part a westward extension of the East Asiatic phytogeographical region, though separated from China by high mountain ranges and deep gorges. Temperate forest covers most of the North Triangle between 5,000 and 9,000 ft., and includes a great variety of broad-leafed trees, both evergreen and deciduous.

(iii) *Silver Fir—Rhododendron Forest*. This, the highest forest belt, is under snow for at least three months in the year in the Arahku-Hkinlum area, and for six months in the year further north, where the mountains are much higher.

Pine forest, described in the earlier monograph, is entirely lacking in this part of the North Triangle, where we did not meet with a single Pine tree.

Mixed Temperate Forest is also lacking; we found neither *Picea*, *Larix*, nor *Tsuga*. In fact, the only Gymnosperms we noted, other than *Abies*, were a dwarf *Juniper* and *Taxus*—both above 10,000 ft.; and two very rare species down in the valley at 4,000-5,000 ft.—a *Cephalotaxus* (probably *C. manii*) and an unidentified genus with leaves like a *Metasequoia*. This last, a big tree, was exceedingly rare. We saw no sign of *Taiwania*.

The three main forest types briefly mentioned above are further divisible on the basis of dominant families or genera, and species frequency, many species having a considerable vertical range, with of course an optimum altitude. Thus, the broad belt of tropical evergreen forest which fills the deep valleys and spreads upwards into the foothills, can be subdivided into a lower, narrow tropical belt, and an upper, broader sub-tropical belt, although at intermediate altitudes the distinction between them is necessarily blurred. It is worth noting, however, that a change of forest type is almost always accompanied by a change in the dominant Bamboo genus, or species.

Again, in the temperate belt, a distinction between the lower warm-temperate and the upper cool-temperate forest is not difficult to uphold. We may therefore recognise five forest types in the North Triangle, out of the eight described for North Burma in the earlier monograph. It will be useful to give a brief account of each, mentioning a few of the more outstanding trees; a fuller account must await the working out of our collections.

I. Tropical Evergreen Rain Forest

This type is barely represented in the Arahku-Hkinlum area, and need not detain us. Even at 3,000 ft. altitude, where the summers

are hot, and no frost enters, and with ample atmospheric humidity throughout the year, the effect of the adjacent high peaks is already beginning to make itself felt. A number of trees mentioned in the earlier monograph as characteristic of this zone (e.g. *Terminalia myriocarpa*, *Mesua ferrea*, *Duabanga sonneratioides*, *Gmelina arborea*, *Dipterocarpus*, *Shorea*, *Spondias*), though occurring lower down the valley, had disappeared before we reached Hkinlum. Nevertheless, the forest lining the Hkrang Hka gorge, though composed largely of species not seen at Sumprabum—or even in the valley of the Mali Hka—comes within our conception of tropical forest. Common trees here include species of *Elaeocarpus* (at least four species), *Echinocarpus*, *Styrax* (two or three species), *Eugenia*, *Manglietia*, *Albizzia*, *Dipterocarpus*, *Shorea*, *Spondias*), though occurring lower down the one strangling species), besides several big Laurels, Euphorbiaceae, Rubiaceae, and others. Though forming only a small proportion of the total forest, this zone is interesting by reason of several rare species, and of importance because of its lining the steep river banks —rivers being the only economic means of transport under present conditions. The rarest tree met with—a single specimen of *Cephalotaxus* (and the strangest plant—an epiphytic Lily of the 'Martagon' type) belong to the borderline between tropical and sub-tropical forest.

II. Sub-Tropical Hill Jungle

This is well represented in the North Triangle between 4,000 and 6,000 ft., above which it passes gradually into a definitely temperate forest type. It lies entirely within the zone of cultivation, and on south and west slopes is represented mainly by second growth which, however, may include woodland of 20 or more years' standing. (Such woodland is set aside for furnishing building poles.)

By far the most interesting tree is a tall Gymnosperm whose identity, in the absence of flowers or fruit, we were unable to determine; though microscopic examination of the wood is likely to furnish a clue. It is an extremely rare species, at least as a fully grown tree. Common are species of *Diospyros*, *Rhus*, *Pieris*, *Schima*, *Elaeocarpus*, *Terminalia* (?), *Styrax grandiflora*, *Zanthoxylum*; also *Altingia excelsa*, *Erythrina indica*, *Alnus nepalensis*, *Bucklandia populnea*, *Manglietia*, *caveana*. Less common were *Helicia*, *Ternstroemia*, *Eriobotrya*, and *Sterculia* (a small tree with reddish flowers like *S. coccinea*), and the very rare conifer, like *Metasequoia*, just mentioned.

The majority of the species in the sub-tropical belt belong to a few families only, notable to Fagaceae (*Quercus*/*Pasania*, *Castanopsis*), Rutaceae, Magnoliaceae (*Magnolia*/*Michelia*), Theaceae, Rubiaceae, Lauraceae, and Moraceae (*Morus laevigata*, *Ficus*), together with the genera mentioned above.

Climbing plants abound in this warm damp climate, and include species of *Clematis*, *Lonicera*, *Jasminum*, *Smilax*, *Vitis*, *Vernonia*, several Asclepiadaceae and Apocyanaceae. Frequent scramblers are *Toddalia aculeata* and *Aspidopterys* sp.

Characteristic and abundant is the epiphytic flora, including many Orchidaceae and ferns, Ericaceae (*Rhododendron dendricola*, *Vaccinium*,

Agapetes, *Pentapterygium*), Asclepiadaceae, species of *Hedychium*, and so forth; also the lily just mentioned.

The composition of the hill jungle, however, varies considerably with its distance from the high peaks. Nearer the peaks, the more tropical families rapidly decrease, while the more temperate families increase in numbers and variety.

There are many useful and possibly valuable timbers, but no species forms pure stands; and extraction, except perhaps close to the larger streams, is a major problem.

III. Warm-Temperate Rain Forest (5,000-7,000 ft.): Cool-Temperate Rain Forest (7,000-9,000 ft.)

In the North Triangle this type agrees fairly closely with the description given in the earlier monograph; the differences noted are mainly those of composition, a number of new species being added, while many of those mentioned as characteristic (e.g. *Decaisnea*, *Dobinea*, *Pottingeria*), were not met with in the Arahku-Hkinlum area.

Perhaps the most striking trees of the Warm-Temperate belt are *Gordonia axillaris*, with flowers six inches in diameter, *Rhodoleia forrestii*, *Helicia excelsa*, and several species of *Rhododendron*, including *R. stenaulum*, *R. genesterianum*, and a 'Ciliicalyx' species. Oaks, Laurels and Magnoliaceae abound; also a species of *Calamus* which ascends to nearly 7,000 ft. The epiphytic flora, which includes several shrubs—notably *Agapetes*—is varied; but climbing plants, lacking the summer heat they need, are on the down grade.

There are a few deciduous trees, but not enough to colour the autumn forest. On the other hand, several autumn-flowering trees are sufficiently abundant to brighten the slopes in November.

Several of the trees mentioned serve to indicate the upper limit of the warm-temperate zone, but the dividing line must never be regarded as fixed; on the contrary, the number of genera with species in several zones, ranging sometimes through 6,000 ft., is a measure not only of its fluidity, but also of the fierce, continuous struggle which goes on always between the floras of two superimposed phytogeographical regions to extend their boundaries.

This is apparent not only regarding familiar genera such as *Ilex*, *Castanopsis*, *Quercus*, *Rhododendron*, and *Acer* (4,000 to 9,000 ft.), but equally amongst others less familiar, such as *Eriobotrya* (4,000, 7,000 ft.); *Helicia* (3,500, 6,500 ft.); *Styrax* (four or five species, 3,500 to 8,000 ft.); *Pieris* (3,500 to 9,500 ft.); *Schima* (4,000 to 8,500 ft.); and *Symplocos* (3,500 to 9,500 ft.). *Bucklandia populnea*, to mention but one species, has a vertical range of over 4,000 ft. in the Arahku-Hkinlum area.

Thus mutual pressure is exerted by one phytogeographical region on another, not only laterally where these adjoin, but also vertically in the mountains.

The next zone, the Cool Temperate forest, in latitude 27°N. is in some respects equivalent to the forests of lower altitudes in much higher latitudes—perhaps to those of the moister parts of western Europe. Its composition is, however, partly Eastern Asiatic. Here

autumn colour becomes a major feature; indeed, the forests flush with colour twice a year—in spring, when the magnolias, rhododendrons and cherries come into blossom, and the breaking leaf-buds add a rich mosaic of greens, yellows, purples, and reds; and again in autumn when the dying year flings a patchwork of scarlet and gold over the hillsides.

Amongst the most brilliant trees at this season may be counted *Sorbus*, *Acer*, *Viburnum*, *Gamblea*, *Enkianthus*, and *Pyrus*. During the height of the rains, however, and in the depth of winter, the temperate forest is sombre indeed; for the truth is that even at 9,000-10,000 ft. it is still largely evergreen, with rhododendrons, *Ilex*, *Symplocos*, oaks, some laurels, and some Magnoliaceae retaining their leaves; while other trees (e.g. *Eriobotrya* sp.) are naked only for a very short time.

This is the zone of the big-leafed tree rhododendrons, of *R. sino-grande* and others, one of which, with glorious yellow flowers, was outstanding in May. (We did not see any of the others in bloom.) The big-leafed species ('*grande*' and '*falconeri*' series) at 9,000 ft. tend to form almost pure Rhododendron forest; and though their trunks are gnarled and twisted to an extraordinary degree, they are large enough and abundant enough to provide an unlimited supply of timber for special purposes. The wood is extremely hard and close-grained, and takes a good polish. It would be valuable for veneer and panelling. These trees seemed to be immortal; I estimated many of them to be over 200 years old, and rarely did we see a dead rhododendron.

There is also a great variety of shrub rhododendrons, including a number of epiphytic species. In fact, in the cool-temperate forest *Rhododendron* and *Magnolia* are dominant genera, so much so that it might properly be defined as the zone of Magnoliaceae and Ericaceae.

Notable trees are *Magnolia rostrata* and *M. Campbellii* (*mollicomata*), *Ilex crenata nothofagifolia* (very different in appearance from the Japanese *I. crenata*), and *I. sikkimense*, *Acer wardii* and *A. sikkimensis*, and species of *Tetracentron*, *Zanthoxylum*, *Michelia*, *Eriobotrya*, *Schima*, *Betula*, *Styrax*, *Illicium*, and several large Araliaceae and Fagaceae (*Quercus lamellosa* and *Q. pachyphylla*).

Two species of *Primula petiolares* and a 'Candelabra' species—likewise belong to this zone, together with species of *Begonia*, several ground orchids, and a few Compositae.

A noted feature is the swathing of the big trees with moss, which not only pads the trunks but hangs in long festoons from the limbs. In this moss a variety of perennial epiphytes, both woody and herbaceous, spring up from seed; in fact, there is hardly a tree in the forest which cannot start life thus, while many continue as epiphytes all their lives, and when fully grown are often connected with the earth as well, by means of a great root which has grown down the side of the trunk till it reached the ground (e.g. *Sorbus*). They are partial epiphytes. The thin-barked rhododendrons, however, carry no moss.

It is surprising that neither in this, nor in any higher zone, did we meet with a single species of *Berberis*, so many species of which occur further north; and with only one species of *Cotoneaster*.

IV. Rhododendron-Silver Fir Forest

The Burmese, and probably Chinese, Silver Fir is found on sheltered slopes as low as 9,000 ft. in the North Triangle, as high as 12,000 ft. in North Burma generally. Though it forms practically pure stands, the trees are rather far apart, the intervening space being filled with *Arundinaria* and *Rhododendron arizelum*—one of the big-leafed trees, and to a lesser extent with another tree species of the 'Thomsoni' species. In the earlier monograph I referred the Burmese Silver Fir to *Abies fargesii*; but whether the North Triangle tree is this species or not remains to be seen.

A number of broad-leafed, mostly deciduous trees are associated with the Silver Fir, notably *Gamblea*, *Clethra delavayi* (?), *Pyrus*, and *Sorbus insignis* (*S. harroviana*?); besides numerous shrubs, especially species of *Rhododendron* and *Gaultheria*. It may be remarked that *Abies* is practically confined at this altitude to the more sheltered slopes, being unable to withstand bright sunshine. Hence, in this zone we find three distinct plant associations: (i) sheltered slopes covered with Abies—Rhododendron forest; (ii) exposed slopes, with Rhododendron—broad-leafed deciduous trees, mostly of small size; and (iii) ridges which, being exposed to both wind and sun, are covered mainly with mixed shrub growth of low stature, including many species of rhododendron [*RR. tephropeplum*, *telopeum* (?), *trichocladum*, *polyandrum*, and others], mixed with *Euonymus*, *Enkianthus*, *Symplocos*, *Viburnum*, *Gaultheria*, *Vaccinium glauco-album*, *Taxus*, and many other species. All three associations have *Arundianaria* as a fill-in.

Another point of interest is that *Abies*, the only tree other than rhododendron to form pure stands, is local in its occurrence. Thus, while it was a dominant on Tama Bum at 10,000-11,000 ft., we did not come across a single tree on Tagūlam Bum, only a few miles to the north and very little less in altitude. One gets the impression that, though a tough-looking tree, it is in reality sensitive to slight differences in climate.

There was no sub-alpine meadow association within this zone (or, indeed, anywhere else) such as is typical of the higher ranges along the China-Tibet frontier. The nearest approach to this was in the steep, sheltered gullies, which, being drained dry in their upper parts by October, carried only a limited variety of coarse herbaceous plants, forming nevertheless a type of sere. The more outstanding plants in these gullies were: *Caltha*, *Cimicifuga*, *Nomocharis*, *Polygonum*, *Luzula*, *Pedicularis*, *Rodgersia*, *Astilbe*, and several Compositae with large leaves; besides a few shrubs, including a *Lonicera*.

Forest in General

Since the various types of forest are in three-dimensional contact, as opposed to two-dimensional contact on flat land, over wide areas a good deal of interchange of species takes place. Every zone tries to expand its boundaries, and incorporate within itself something of the zone below and the zone above. Even alpine species penetrate as far down the gullies as they can, while cool temperate species strive to become alpines. This, of course, is what one would expect,

since there are always transitional zones; nothing is hard and fast.

But while species may, and often do transgress boundaries, different species of the same genus regularly occupy different zones. Obvious examples in North Burma are *Rhododendron*, with species in every zone from 1,000 ft. above sea level (*R. simsii*) to 14,000 ft. (*R. chryseum*); and *Ficus*, with species in all zones between 1,000 ft. and 10,000 ft. But whereas the former is much more abundant above 8,000 ft. than it is below, the latter is far better represented at 2,000 ft. than it is at 9,000 ft. Hence, one suspects that *Ficus* is a tropical genus which has worked its way up to a temperate climate, while *Rhododendron* is a temperate genus which has worked its way down to a tropical climate.

Certain species of *Rhododendron*, having become gregarious, have made their own small zones, e.g. *RR. sino-grande* and *arizelum*, which form together, or with other species, or even alone, a zone of rhododendron forest, while others form rhododendron scrub. Whole sections of the genus are confined to particular zones. This, however, is not exceptional; rather is it the rule, though on a less generous scale.

Amongst common genera which have overflowed into two or more zones one might mention *Quercus*, *Acer*, *Ilex*, *Magnolia*, *Michelia*, *Elaeocarpus* (mainly in the lower zone, however), *Euonymus*, and *Prunus*. Of all these we met with several species. In the North Triangle also grows a species of *Rehderodendron*, quite a common constituent of the forest between 4,000 and 5,000 ft.; at 8,000 ft. it was replaced by a second species. The same with *Helicia* (Proteaceae)—one species at 4,000 ft., a second at 7,000 ft.; while *Eriobotrya* had four species, the lowest at 4,500 ft., the highest at 7,500 ft.

Alpines, too, try to extend their territory downwards, e.g. a species of *Nomocharis*, found inside the forest at 8,500 ft., and on the open ridge at 10,000 ft.

The fact that one finds such a genus as *Symplocos*, usually reckoned as sub-tropical, at 8,500 ft., and various Lauraceae at 8,000-9,000 ft., is another indication of the concerted attempts being made by the lower zones to extend upwards.

It is worth noting that the green fruits of *Rehderodendron* sp. from 4,000 ft. are regularly eaten (i.e. the rind) by the local inhabitants.

It will be remarked that we actually passed through three main vegetation belts or climax, belonging to three different phytogeographical regions:

(i) Tropical Indo-Malayasian forest;
(ii) Temperate forest (Eastern Asiatic and Northern phytogeographical regions);
(iii) Alpine (which comprises a region by itself) Sino-Himalayan.

In the latest exposition of phytogeographical regions, Prof. Ronald Good has increased the number formerly recognised to 36.[1]

[1] The Geography of the Flowering Plants, 1st edition, London 1947.

That the number must be increased as we get to know more and more of the world's flora, and the distribution of species and genera, is highly probable. But Prof. Good seems to me to be in advance of our certain knowledge. How many divisions we allow depends, of course, mainly on what degree of peculiarity—especially endemism and its degree (specific, generic, or family)—we insist on. (Prof. Good himself doubts the justification for his Continental South-east Asiatic Region.) It also depends on the results of continued exploration.

For the present I am conservative enough to keep to the old comprehensive Indo-Malaysian region. We hardly know enough about the huge flora of Indo-Malaysia as yet to sub-divide it. Such knowledge as we do possess suggests that the first sub-divisions to make would be to detach Ceylon as a separate region, in spite of its proximity to India.

Economics

The question arises: have these extensive forests any economic future? Are there any valuable products and, if so, is it possible, or worth while, to extract them?

The absence of pure stands of any big tree other than *Abies*—the most inaccessible of all—suggests that the answer is an immediate 'no'. On the other hand, it seems certain that many useful, even valuable, hardwoods occur at much lower altitudes, though even here the problem of extraction, at any rate on a big scale, is almost insoluble. Two possible methods, however, may be briefly referred to:

(i) It would be worth while to test the Mali Hka and Hkrang Hka (below Laja a fair-sized river, especially during the rains) for floating logs down to Myitkyina; though it is certain that there would be awkward places where jams would occur. Thus, it would be necessary to maintain a series of patrols, with knowledge of how to free logs, along the banks. It might be advisable to obtain the services of lumberjacks from Canada or elsewhere to train the necessary personnel.

The Mali Hka should, of course, be tested first, by throwing in, say, one hundred marked logs at the Hkrang Hka confluence and keeping a watch for them at Tanghpre; though even here patrols might be necessary. If this proved successful, tests might be carried out on the Hkrang Hka from Laja (above which village the river rapidly breaks up). The fact that heavy planks (not logs) are successfully floated down the Ngawchang Hka—a river little superior, if any, in size to the Hkrang Hka—suggests that it would be worth while to examine the possibilities of the latter river.

Only trees which grow close to the river could be regarded as accessible, whereas many of the more promising timbers grow high up in the temperate zone, far above the river. These, however, are not for ever out of reach, if the methods adopted in western China and in Tibet are adopted and developed. There, stout building poles are cut and roughly shaped in the forest, high above the villages. A narrow gutter is then cut straight down the steep mountain face,

along which the poles are dragged with ease. As the gutter becomes smoother with constant friction, and in winter when it becomes filled with snow (rapidly compacted into ice), the effort required is much diminished. Admittedly, conditions in the North Triangle are very different. The heavy summer rain would tend to deepen and roughen the gutters; and it is only where the mountains exceed 12,000 ft. that there is any great quantity of snow descending so low as 9,000 ft. But taking the long-term view, it might be possible to develop a system of timber slide and river transport adapted to local conditions. (For example, a gutter lined with bamboos laid lengthwise would be extremely slippery.) It is not suggested that timber could be extracted thus on a commercial scale; but it seems a pity that with water available, its possible uses should not be explored.

(ii) In the Htawgaw Hills (south-east Kachin State) the Chinese export—or used to export—heavy coffin planks cut from the Gymnosperm *Taiwania cryptomerioides*. These coffin planks, weighing from 80 to 100 lb. each, were carried one by one some ten days journey over the high dividing range to Tengchung in Yunnan—a journey which involved crossing the Hpimaw Pass, 10,000 ft. high. It would be impossible to extract logs of this big tree—one of the largest in the forests of North Burma; but by cutting the planks to the required shape at the spot where each tree is felled (*Taiwania* does not grow in pure stands), floating them down the Ngawchang Hka, seasoning them for a year, and using human transport, thousands of coffins have been made and sold. Chinese carpenters are sent into the Kachin State to cut the planks; and the industry, though a small and luxury trade, is well organised.[1]

It will be observed that both the above methods of extraction from difficult terrain, as practised today, depend upon a special technique applied to a particular species required for a known purpose. In Canada, soft woods are required on a huge scale for the immense paper pulp industry, the pulping machinery being sited on the river used for floating the logs, as high up the valley as possible. In the second example, the extraction of a single species of soft wood for the manufacture of one article—coffins—in limited but steady demand shows what is possible with scattered trees.

It is suggested that, since it is not possible to extract timber wholesale from the North Triangle, efforts should be made to extract planks, provided that they have a certain known value for a particular purpose.

Before this could be done, it would be essential to know more about the forests—what species occur there, in what quantity, and for what particular purpose they would prove most useful. Until more information is available, it would be a mistake to embark on extensive and expensive operations. Indeed, it is of the greatest importance to know what raw materials exist, and to develop such a potentially valuable industry step by step. The emphasis here is on exploration.

Apart from timber, the forests yield minor products used in the arts—many species of bamboo and cane, for example, used by the local

---

[1] See The Chinese Coffin Tree, *Geographical Magazine* (London), November 1952.

inhabitants for a variety of purposes, from water pots and drinking vessels to suspension bridges and house floors.

Another potential minor product is horticultural plants; and here again there is scope for further exploration to reveal new species which will always be in demand. First place may be given to orchids, so popular nowadays everywhere—even in countries with a cold climate. The forests of the Kachin State are as rich in orchids as is any other part of the world of equal area; and there are even a few species of considerable merit, which are under snow for a few months each year. But, as already pointed out in an article in the *Burmese Forester*, the exploitation of these is best left to private enterprise. It may be said categorically, however, that anyone who took up with enthusiasm the cultivation of Burmese orchids for export could earn a living.

Secondly, there is ample material in the mountains for a successful seed, or even nursery business, although for the latter purpose capital would be required and the nursery would have to be in the hills. There are potential markets all over the temperate world, and the higher mountain tops everywhere are covered with desirable horticultural plants, the seeds of which would find a ready sale, yielding a modest profit. A successful seed business has been set up in Darjeeling, while in Japan there are a number of exporting nursery firms.

Any such business must be content with a modest start, and knowledge—often bought at a price—is needed as well as enthusiasm; but the good taste of the Burmese is a valuable asset in the choice of suitable plants. The expense of collecting orchids and seeds would be negligible.

Lastly, mention must be made of medicinal plants, many of which find a ready sale in China. We did not come across the oft-acclaimed *machit* (the Kachin word; botanically, *Fritillaria roylei*), because the mountains we were exploring are not sufficiently high for this species. It can confidently be asserted that it does not occur anywhere south of Putao (except possibly east of the Taron); but it is abundant further north, at altitudes of over 12,000 ft.

Coptis teeta, another favourite Chinese drug (*hwang-lien* is the Chinese name), is not rare in the forests above Hkinlum at 7,000-8,000 ft.; and where it occurs its spread is easily induced by clearing the undergrowth. It would, however, be profitable to cultivate it on a much larger scale, concentrating it in one place. Only the yellow root is used, so that its collection involves the death of the plant. The best method would be to raise it in fields and plough it up when mature, replanting the fields in rotation. It is, however, a forest plant requiring heavy shade, and the best method of cultivation would be a matter for experiment.

There is also the plant known locally as *Mashaw tsi*, after the village of Mashaw (between Htingnam and Laja), which is reputed to have a monopoly not only of its sale but also of its occurrence! The claim seems extravagant. To bolster up the myth of exclusiveness, stories are circulated locally of its peculiar appearance —stories which to the botanist hardly ring true. However, we were unable to break through the veil of secrecy which envelopes this plant, and ascertain its relationships. Substitutes are readily palmed

off on the too curious, though there is some evidence in favour of its being a species of *Euonymus*. During our sojourn at Hkinlum the discoverer of this patent medicine, who called himself the Mashaw-tsi Duwa, died; but his mantle doubtless descended on another member of the family.

The one authentic fact which emerges from the cloud of rumour and speculation concerning this mysterious plant is that it is used mainly in connection with poisoning including alcoholic poisoning (or more briefly, drunkenness), and with undoubtedly good effect, as reported by a doctor in the district.

These notes on the flora and vegetation of the North Triangle do not claim to be exhaustive, and indeed, until the collections made by U Tha Hla and U Chit Ko Ko and by ourselves have been worked out (a long job, since the total number of species is about 1,500), no complete account of our joint discoveries is possible. Incomplete as it is, however, it should, in conjunction with the valuable field notes made by U Tha Hla, prove of some interest to the Forest Departments of Burma and India.